

LAW Pilot Melter Facility Lessons Learned

Glenn Diener – Energy Solutions
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Overview

- Pilot Melter Background
- Design/Construction/Installation
- Commissioning
- Testing
- Melter Feed Studies Program





LAW Pilot Melter Background

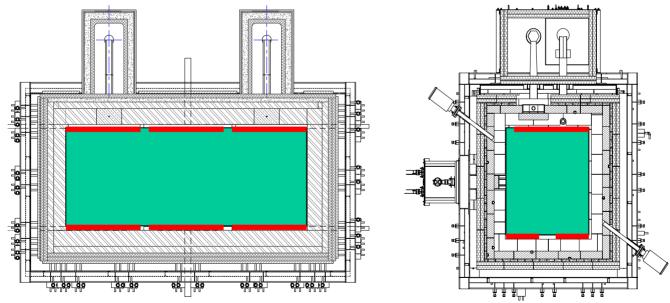
- Under Part B1, BNFL awarded RPP privatization contract
- LAW production rate requirements were deemed a very high risk
- Energy Solutions designed, constructed, and operated large scale melter using Hanford simulated waste
- Funded separately from RPP Part B1 contract





LAW Pilot Melter Facility

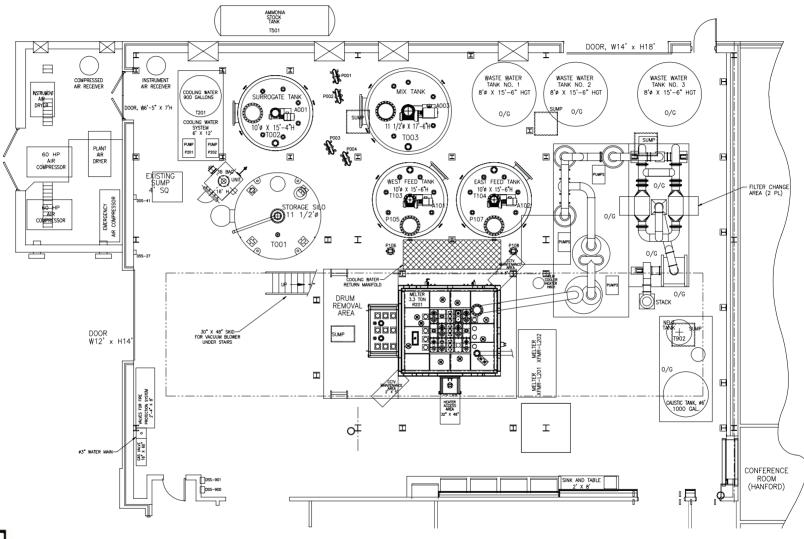
- Initial investment of \$15 million included:
 - Pilot melter (1/3 section of the WTP LAW melter)
 - Melter feed preparation system
 - Off-gas treatment and wastewater collection system
 - Utilities (air, steam, cooling)







LAW Pilot Melter Facility Layout







LAW Pilot Melter System









LAW Pilot Melter Feed System









ENERGY SOLUTIONS

LAW Pilot Melter Off-Gas System









LAW Pilot Melter History

- Jan. 1998: BNFL funding approved (start design)
- July 1998: Begin construction
- Dec. 1998: Melter startup
- April 1999: Begin feeding
- May 1999: Start phase 1 testing
- Aug. Sept. 1999: Sustained throughput test
- Nov. 1999 Oct. 2000: Phase 2 testing
- May 2001: Transfer of Pilot Melter to DOE
- June 2001 May 2003: BNI R&T LAW testing
- Sept. 2003: Full-scale HLW/LAW canister filling
- Oct. 2003: ORP melter testing
- Feb. 2004: Completed D&D of facility





LAW Pilot Melter Scope

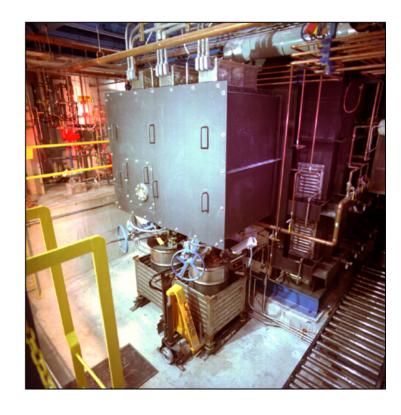
- Phase 1 Scope BNFL
 - Establish melter throughput/reliability
 - Establish refractory performance
 - Define melter operating parameters
- Phase 2 Scope BNFL
 - Sulfate management
 - Melter component improvements
 - Continued validation of melter design
- B2 Scope BNI
 - Enhanced throughput demonstration commissioning goals
 - Bubbler life extension enhanced availability
 - Continued design confirmation and validation





LAW Pilot Melter Statistics

- At temperature for 4.86 years
- Melter fed for 628 days
 - 1,075,395 gallons of feed processed
 - 7,762,390 pounds of glass produced
- Outstanding safety record
- All LAW sub-envelopes processed (nominal, variations, and turnovers)







Design, Construction and Installation

- Design of melter, feed system, off-gas system and I&C performed in-house
 - Utilized engineering personnel with first-hand operations experience
 - Integrated team approach
 - Design guided by the goals of the facility
- Final detailed design of off-gas system and I&C out-sourced





Design, Construction, Installation (cont)

- Things that went well
 - Melter and feed system installation
 - Excellent mechanical/electrical contractor
 - Worked well together
 - Communication was key
- Things that could have gone better
 - Meeting desired installation schedule
 - Change control issues with off-gas and I&C vendors
 - Automation of equipment controls
 - Quality of instrumentation supplied by vendor
 - Quality of equipment supplied by vendor





Design, Construction, Installation Recommendations

- Fully define operating requirements during design
- Do not always rely on success-driven schedule
 - Allow sufficient time for all phases
 - Put contingency into schedule for unknowns
- Do not allow schedule to dictate design and installation
 - Correct design issues upfront
 - Do not "put off" design issues to commissioning
 - Schedule may slip, design cost may increase
 - More cost efficient in long run
- Remember that facility is operated by people
 - Safety considerations
 - Equipment placement (operability, maintenance, etc.)
- Utilize best instrumentation possible for data collection





Commissioning

- Commissioning performed in phases
 - Component checkout
 - System checkout
 - Water runs
 - Simulant testing
- Checklists developed by test engineers
 - Verify interlocks and control strategy
 - Verify proper operation of equipment
 - Determine limits of operation
 - Verify instrumentation calibration





Commissioning (cont)

- Commissioning performed by operations
 - Responsible for developing operating procedures
 - Verify operating procedures are correct
 - Used to help train operators
- Initial commissioning performed on days
- Once melter was hot, 24 hour operator coverage
 - 12-hour shift rotation, 4 shifts
 - 1 supervisor, 2 melter operators, 1 auxiliary operator
- Full implementation of conduct of operations
 - Based on manual from Energy Solutions' M-Area vitrification facility at SRS





Commissioning (cont)

- Commissioning used to fully train operators
 - Basic sciences (math, physics, fluid dynamics, etc)
 - System training (component interaction)
 - Job Performance Measures (task related)
 - Regulatory training (HAZWOPER, L/T, confined space, etc.)
 - Comprehensive oral test with Operations Manager
- What went well
 - Operator training
 - Conduct of Operations implementation
 - Commissioning process and methodology





Commissioning (cont)

- What could have gone better
 - Commissioning cut short due to delays
 - Lingering equipment/design issues carried into testing – deemed an acceptable risk
 - Testing of automatic controls overly complex
- Recommendations
 - Utilize operation staff for commissioning, not just engineers
 - Allow sufficient time for commissioning always takes longer than estimated
 - Resolve problems before turnover may impact schedule





Testing Methodology

- Testing program plan
 - Identified roles and responsibilities
 - Identified how testing is conducted
 - Requirements for test plans and test procedures
 - Configuration and change control
 - Test report development, review, and approval
- Test engineer assigned for each test
 - Receives approved Project test specification
 - Develops test plan and test procedure
 - Trains operations staff on test procedure
 - Coordinates testing with shift
 - Collects data and performs data reduction
 - Develops test report





Testing Methodology (cont)

- Configuration Control
 - Controlled documents, drawings, and ECNs
 - Test Authorization Document
 - Identified authorized test procedures
 - Identified configuration of facility equipment and operating conditions
 - Identified authorized plant maintenance
 - Identified allowed routine operations
 - Controlled copy maintained in the control room
 - Test procedures modified by field changes or revision
 - Test procedure, operating logs and electronic data (via PLC) used to collect required test data





Testing Methodology (cont)

- Operations
 - Facility operated as a production plant 24 hrs/day, 7 days per week
 - Operators followed operating procedures
 - Test procedures used by engineers to guide operations
 - Test procedures referenced operating procedures
 - Conduct of Operations fully implemented
 - Documented shift turnovers between operators
 - Temporary operating changes handled by shift/standing orders
 - Operating logs maintained
 - Communications
 - Face-to-face or by radio
 - Management available 24/7 via mobile phone





Simulants Used in Testing

- LAW simulants based on VSL formulations
 - Based on TFCOUP data
 - Mixed chemical simulant
- Simulants produced by Optima Chemical
 - Simulants manufactured in ~3500 gallon quantities
 - Simulants shipped by tanker truck
 - Simulants received at higher molarity than needed
 - Received COC Al, Na, K content, density, and pH
 - Received completed batch sheets
 - 685,850 gallons received and processed





GFCs Used in Testing

- GFCs based on VSL glass formulations
 - GFC grade/particle size based on VSL testing
 - GFC grades eventually specified by BNI
 - GFC added to achieve a specific solids loading and rheology
- GFCs blended by Colonial Chemical
 - GFCs received by hopper truck (~45,000 lbs)
 - Received completed batch sheets
- 7,059,186 lbs received and processed
- Solids handling issues during summer
- Chemical purity problems vendor replaced





Testing - Safety

- Modifications and maintenance initially handled verbally with shift
- LTA resulted in complete implementation of a work control process
 - All work not covered by procedures required work packages
 - Based on Energy Solutions' work control manual from M-Area vitrification facility at SRS
 - Scope of work and boundaries clearly defined
 - All facility changes required safety and operations review

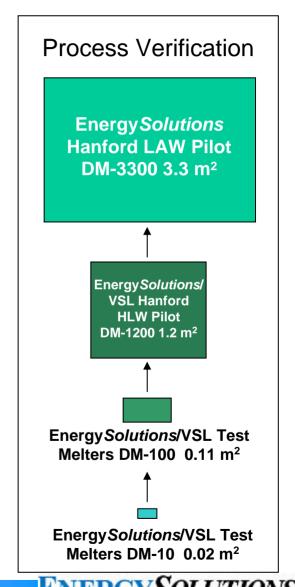


LTA reduced to zero after integrated safety program implemented (over 3.75 years)



Testing – What Went Well

- Safety program
- Training program
- Facility operations
 - Skilled, experienced people
 - Maintained core competency
 - Roles and responsibilities clearly defined
- Testing Program
 - Goals and testing identified early
 - Success ensured by process verification at smaller scale
- Analysis by VSL





Testing – What Could Have Been Better

- Maintenance of off-gas equipment
 - Materials/equipment selected based on facility life
 - Replaced piping and pumps
- Transfer of operating experience
 - Success may foster complacency
 - Important for effective facility design
 - Prevents loss of competency





Organization Testing Philosophies

BNFL

- Design confirmation testing
- Technology improvement
- Testing requirements generalized, allowed for innovation

BNI

- Design confirmation/validation testing
- Operation, engineering, permit data collection
- Testing duration limited by funding
- Testing requirements prescriptive, little innovation

ORP

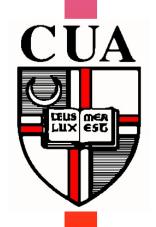
- Technology improvement and enhancement
- End of melter life testing
- General testing requirements







Melter Feed System Lessons Learned



Melter Feed Studies Overview

- Wasteform qualification testing for LAW/HLW
 - Verify tank homogeneity over range of tank levels
 - Verify prototype sampling system collects representative sample
 - Quantify accuracy/precision of radar level and density measurements
- Testing conducted with bounding simulants
 - LAW pretreated waste and melter feed
 - HLW pretreated waste and melter feed
 - Simulants developed by SRNL

UA Testing performed on day shifts





Melter Feed Studies Equipment

- 8-foot diameter scaled tank (2500 gallons)
 - LAW CRV (57% scale)
 - LAW and HLW MFPV (73% scale)
- Scaled tank contains
 - Prototypic agitator (scaled)
 - Prototypic transfer pump (full-scale)
 - Prototypic density probe (full-scale)
 - Prototypic radar level detector (full-scale)
- Full-scale Isolok sampling valve
- Hydraulically similar transfer piping
- GFC unloading station for prototypic addition rates



Melter Feed Studies Facility









Melter Feed Studies Facility









Melter Feed Studies Testing

- What went right
 - Modular design of the tank system
 - Allows for quick reconfiguration
 - Part of design requirements
 - Tank sampling probe system
 - Automated sample labeling and handling system
 - Minimizes sample labeling errors
 - All paperwork automatically printed
 - Reduces manpower requirements
 - Sample analysis
 - Identified potential equipment operating problems
 - Isolok sampling system
 - Radar level detector





Melter Feed Studies Testing (cont)

- What could have been better
 - Equipment operating problems
 - Resolving equipment problems that were outside scope of testing
 - Delay in testing schedule/increase in cost
 - Simulant scale up testing
 - SRNL simulant development testing at small scale only
 - LAW high bound melter feed rheologically unstable at large scale (due to xanthum gum)
 - New simulant being developed by VSL
 - Testing requirements
 - Test Specifications too generic (time lapse between development and start of testing)
 - Project needs evolved over time





Summary – Testing Recommendations

- Develop/implement a strong safety program
 - Needs to make people think
 - Needs to be focused on the people doing the work
- Develop/implement a strong training program
 - Focus on systems and their interactions
 - Qualify personnel on tasks
- Utilize experienced personnel (first hand, real life operating experience)
- Define requirements/needs of facility early
 - How long is it needed?
 - What needs to be determined/validated?
 - Are requirements operations or R&T based?





Summary – Testing Recommendations

- Involve engineering throughout testing, not just during design phase
 - Promotes competency of personnel
 - Promotes understanding of system interactions
 - Invaluable feedback for plant design
- Utilize smaller scale testing first
 - Identifies operating problems faster and cheaper
 - Engineering judgment needed for scale up



